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BRITISH WEST INDIES FRUIT AND VEGETABLE CONFERENCE.

A NOTE ON PYRETHRUM AS A POSSIBLE INSECTICIDE FOR THE CONTROL OF THE SUGAR-CANE FROGHOPPER.

CITRUS SCAB DISEASE ON GRAPEFRUIT IN TRINIDAD

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BRITISH WEST INDIES FRUIT AND VEGETABLE CONFERENCE.

It will be remembered that considerable attention was paid at the West Indian Intercolonial Fruit and Vegetable Conference, which was held in Jamaica in 1933, to the problem of the co-ordination of the production and marketing of fruit and vegetables in the British West Indies. One of the main recommendations of this Conference was that two West Indian Fruit and Vegetable Councils should be established—one for the Eastern Group comprising British Guiana, Trinidad, the Windward and Leeward Islands, Barbados and Bermuda, with headquarters in Trinidad, and one for the Western Group consisting of Jamaica, British Honduras and the Bahamas, with headquarters in Jamaica. Both these Councils were subsequently organised and two meetings of the Eastern Group Council have already been held, the first in St. Lucia in 1935, and the second in Trinidad in 1937.* The third meeting of the Eastern Group Council for which arrangements were made early this year, was held in February at the Imperial College of Tropical Agriculture, when the opportunity was also taken to hold the first joint Conference of representatives from the Eastern and Western Groups. This joint conference, under the chairmanship of Sir Geoffrey Evans, was attended by representatives from Jamaica, British Guiana, Trinidad, Grenada, St. Vincent, St. Lucia, Dominica, Antigua and Montserrat, and by the Trade Commissioner for the British West Indies (Eastern Group) and British Guiana in Canada. It not only afforded an excellent opportunity for reviewing the progress which has been made in the growth of the fruit and vegetable industries in the British West Indies since 1933, but also for promoting that closer co-operation in all trade matters which is so essential to the successful development of these industries in the colonies represented.

One of the main items considered at the Conference was the present position and future prospects of citrus. It will be recalled that this industry, and grapefruit in particular, was largely developed upon the recommendations made by an expert who visited the British West Indies in 1928, at the invitation of the Empire Marketing Board. The policy of development which he

* *Tropical Agriculture*, Vol. XII, No. 6, 1935; Vol. XIV, No. 4, 1937.

advocated was subsequently confirmed by the Secretary of State for the Colonies following the Jamaica Conference in 1933. Recently, however, certain reports have been circulated which suggest that the Imperial Government may in the near future reduce the general rate of duty on citrus fruit imported into the United Kingdom. The possibility of such action being taken was viewed with much concern by the Conference and it was recommended that the attention of the Secretary of State for the Colonies be immediately drawn to the disastrous effects which any reduction in, or abolition of, existing preferences would have upon the growing British West Indian citrus industry. It was also recommended that his attention and that of the Canadian Government should be drawn to the serious effects on the British West Indian fruit and vegetable industries which have resulted from the Canada-United States Trade agreement. These effects have been most marked with citrus and miscellaneous vegetables other than tomatoes which are fortunately protected at present by a Canadian preference. Through the abolition of the tariff on American oranges from January to April in each year, however, the West Indian trade in this commodity has received a severe blow, since the peak of Jamaica production is in late December and January. The Conference considered it desirable that the protected period for West Indian oranges in Canada should be extended to include the month of January, and apparently this additional month could be exchanged for an even longer period of free duty for American oranges in the summer months without any present damage to Empire trade in the commodity.

Various aspects of the lime industry were considered. One of the major problems in this industry has been the lack of organisation and control in the marketing of limes and lime products. As it is apparent that the situation in this respect can only be satisfactorily improved by means of centralised advertising directed through a joint West Indian Association of lime growers and other lime interests, the Conference strongly recommended the early formation of lime growers' associations in all the West Indian colonies concerned to be followed by the formation of a West Indian Limes Association. It was also recommended that all West Indian lime producing colonies should institute a system of export cesses or rather contributions to provide funds for this Association. A West Indian Lime Oil Sales Company has already been successfully formed but there are still lime oil producers in various colonies who have not yet affiliated and it is hoped that they will give favourable consideration to such central marketing organisations. It is hoped also to institute an advertising campaign in Canada for British West Indian limes, but with the existing *ad valorem*, intermediate and general Canadian tariffs on this commodity the West Indian islands have little protection from foreign competition. The Conference thought it desirable that in the interests of these colonies, the Canadian Government should be asked to amend the tariff on foreign limes to a specific duty of 2 cents per lb. It further recommended that the assistance of the Secretary of State for the Colonies be sought to represent the desirability of concessions being given to West Indian limes and lime juice entering the United States in the Anglo-United States trade agreement, negotiations for which are now proceeding. In this connection it was felt that the British West Indies have a fully justifiable claim for concessions, not only for limes but also for other vegetable and fruit produce entering the United States, in return for concessions granted to the United States by Canada.

The present position of other fruit and vegetable industries was also examined. With regard to bananas it was felt that every endeavour should be made to stimulate further production in view of their importance as a cash crop in many of the Colonies of the Eastern Group. In view also of the spread of banana leaf spot disease and of the threat which it holds over the industry it was recommended that early steps should be taken to provide the geneticists engaged in banana breeding with wild varieties of bananas necessary to serve as suitable parents for the purpose of breeding, as soon as possible, an immune variety with suitable commercial characters. With regard to tomatoes the Conference noted with satisfaction the efforts of the Bahamas towards the institution of more orderly methods of marketing but suggested the desirability of estimates of acreage and production of this crop in the Bahamas being made available as early as possible for the information and guidance of other producing colonies. The need for further experiments with West Indian and other varieties of avocado pears to provide the planting public with types suitable for export, was stressed. The position of the mango and pineapple industries was also reviewed. It was felt that the absence of suitable and frequent shipping facilities among the colonies of the Eastern Group made development of a profitable trade in mangoes problematical; also as there has been no improvement in the position regarding either fresh or canned pineapples it was thought that there appeared to be no object in carrying out extensive experimental work with this crop at present.

Other questions dealt with by the Conference included the possibility at a later date of establishing a West Indian Citrus Fruit Exchange, the drawing up by the Low Temperature Stations in Trinidad and Jamaica of a schedule of optimum storage temperatures at which West Indian fruit and vegetables should be transported, the desirability of reducing freight rates which recently have been increased, and means by which the services of the Colonial Marketing Board might be utilised for the benefit of the West Indian fruit and vegetable industries.

A NOTE ON PYRETHRUM AS A POSSIBLE INSECTICIDE FOR THE CONTROL OF THE SUGAR-CANE FROGHOPPER.

By Alan Pickles, M.Sc A.I.C.T.A.
(*Entomologist, Trinidad Department of Agriculture.*)

Insecticidal control of the sugar-cane froghopper has chiefly been directed against the nymphal stages during past years. Large scale applications of insecticides to such a crop as sugar cane must always be difficult and the destruction of froghopper nymphs by chemical means has, after several years of experience, proved to be expensive and somewhat irregular in results. The principal objection to the use of "Cyanogas" dust for nymph eradication is that the progress of the work is so slow that only a small proportion of the affected fields can be adequately treated at the optimum time in the case of a widespread outbreak and that, in the case of an outbreak where nymphal emergence is prolonged, only a small proportion of the insects, that is, those actually occurring as nymphs at or near the soil surface, are vulnerable to the treatment.

Destruction of adults by insecticides has received much less attention. The late Dr. Withycombe envisaged the possibility of applying dusts from aeroplanes for the control of adult froghoppers* but his work on this aspect was not completed. In any event, the employment of aeroplanes in Trinidad cane fields during the wet season would appear to be well-nigh impossible without elaborate and expensive preparations.

It seemed possible to the writer that dusts might be employed on a sufficiently large scale without the necessity for using aeroplanes. Modern high power dusting machines could be run in the cane traces on the windward side of the affected fields and it should be possible to treat at least a large proportion of the field without entering amongst the canes. As a preliminary to a practical study of this method of control, it was considered necessary first to discover an insecticide suitable for the purpose and experiments, on which the present paper is a progress report, were accordingly conducted during the wet seasons of 1936 and 1937. The first experiments with pyrethrum were found to be most promising and experiments with other substances have been deferred for the present. It is intended, however, that large scale trial of other substances, particularly nicotine dusts and derivatives of derris, shall be conducted when the necessary equipment is available.

The effect of pyrethrum on adult froghoppers in cages was first tested. Four insect cages of similar type were taken and into each, 100 adult froghoppers were introduced, cut cane leaves standing in water being provided as food. After allowing the insects time in which to settle down, those in three of the cages were treated with pyrethrum dust and with atomised sprays containing pyrethrum. The insecticides employed were (*a*) pyrethrum extract known as "Pyragrol", diluted with refined kerosene to make a four per cent. mixture; (*b*) "Pyragrol" four per cent. in a local Diesel fuel oil; (*c*) pyrethrum dust. All the insecticides were applied from a "Mysto" paint gun and the extracts in oil were not further diluted or emulsified.

After four hours from the time of treatment, all the froghoppers in the experimental cages were dead. Those in the untreated cage showed a mortality of only five insects.

Subsequently, a small scale field trial of the same insecticides was conducted. Owing to the lack of suitable apparatus for distributing the insecticides, the trial presented many practical difficulties and, as will appear, the results are probably much less satisfactory on this account. In addition, the field in which the trial was conducted—the only one available with a sufficiently heavy population—was already blighted. This condition, on account of the withering of the leaves and the contraction of the funnels made it difficult to apply the insecticides directly into the parts where the froghoppers were sheltering.

Seventy-five stools of cane were treated with each of the oil mixtures; on account of the small supply of pyrethrum dust, only forty stools could be treated with this preparation.

Some hours after treatment, the plots were examined and counts were made of the living and dead insects present on the treated stools, care being taken to exclude insects killed through the agency of green muscardine fungus. The results of examination are summarised in Table I.

Table I.

Treatment.	No. of Stools.	Mortality.
		%
Pyrethrum in Diesel oil	75	47
Pyrethrum in kerosene	75	47
Pyrethrum dust	40	64

These results show that a significant mortality of froghoppers can be brought about by the use of pyrethrum. While the mortality so produced is low, it seemed probable that this was due in large part to the difficulties of application of the insecticides. The mortality figures also were probably an underestimate of the actual death roll, since many insects hit by the sprays and dusts flew off the canes and those which subsequently died would not be included in the counts.

* *Minutes and Proceedings of the Froghopper Investigation Committee*, Vol. I, p. 48.

A small block of 15 stools was then given two applications of the Diesel oil mixture and counts of dead and living froghoppers were made after a suitable interval. The froghopper mortality was found in this case to be 67 per cent., strongly supporting the view that a more efficient means of application would have produced a higher mortality.

From this experiment, it was considered that pyrethrum showed definite promise as an insecticide for froghopper control and that further experiments should be conducted.

A second series of experiments was initiated during the wet season of 1937. Since suitable apparatus for applying atomised oil on a fairly large scale was not available, the experiments made use of pyrethrum dust only. A Craven Tornado Marvil power dusting machine was employed. The machine was charged with a mixture of two parts pyrethrum dust and one part of hydrated lime and the machine was wheeled slowly down a cane trace on the windward side of the field, blowing a light cloud of dust over the canes meanwhile. No attempt was made to treat individual stools or parts of stools.

Before the dust was applied, plots were selected from within the area to be treated and the population of adult froghoppers was assessed. After treatment, the populations of living and dead froghoppers were again determined in the same plots and the mortality produced was thus derived.

The results obtained are given in Table II.

TABLE II.

Experiment No.	Original Population per Stool.	Mortality per cent.
1	9.22	79.4
2	33.40	82.6
3	31.00	84.5

These results were obtained by comparing the living populations in the plots before and after treatment. As compared with the earlier experiments, very few dead insects were found on the stools after treatment, most of the froghoppers apparently jumping away when struck by the insecticide. It seems certain, however, that the observed effects are due to a lethal and not merely to a repellant action of the pyrethrum, since the powder used, when tested on caged froghoppers, killed all the insects in a short time. Further, observations on canes adjacent to those dusted in the field showed no increase in numbers, as would be expected if the insects had merely migrated from the dusted stools.

Pyrethrum powder does not adhere well to the cane leaves, but quickly slides down the foliage into the axils. This is probably an advantage when dealing with froghoppers, as most of them shelter in the leaf axils during the hot part of the day and are consequently more exposed to the action of the insecticide than if the latter adhered to the foliage. The machine employed is, of course, unsuited for large scale application of dust to sugar cane, but was most suitable for experimental work. Appreciable quantities of dust could be found over a strip of cane stools four beds wide and, had it been possible to raise the machine from the ground so that the dust could be shot horizontally over the plants, it is probable that the range would have been greater still.

The results are now considered sufficiently encouraging to justify trial on a much larger scale and arrangements have been made for the purchase of materials and equipment suitable for the treatment of large areas during 1938. The immediate problems to be examined are the possibility of applying suitable insecticides to large acreages, the determination of the minimum quantity of insecticide to be effective and the actual costs of operation.

Thanks are due to the Trinidad Sugar Cane Investigation Committee for their interest in and their generous support of this work. Acknowledgment is made to Messrs. John Powell, Inc. and to the Kenya Farmers' Association Ltd. who supplied the materials for the experiments.

TEA MANURING.

IN these notes gathered from recent addresses by members of the Ceylon Tea Research Institute to District Planters' Associations, which have been published regularly in the Tea Quarterly, the results obtained by six years manurial experiments are summarized. Nitrogen is the chief yield-promoter in tea, the response being in direct proportion to the amount applied. The percentage of nitrogen recovered in new growth by the plant from artificial manures amounts to under 20 per cent. No difference has been found between yield capacity of organic and inorganic manures. Potash has never increased yield, but has improved quality. The beneficial effects of phosphoric acid are limited to doses up to 30 lb. per acre. Recovery from pruning is apparently governed by the reserves in the plant, and not by the manures applied when the bush is without foliage. To provide full benefit, manures should be applied early in the pruning cycle. It is shown that an ideal C/N ratio for purposes of plant nutrition can be provided by turning in the leguminous green crops, Dadap (*Erythrina lithosperma*) and *Tephrosia Vogelii*, and the pruning leaf of tea, and that the cost and trouble of composting the loppings merely to produce the same result is unwarranted. Other organic materials, however, produce different and less desirable C/N ratios, and these are tabulated. The best means of conserving nitrogen in the soil, in circumstances where it is an economic proposition, is by green manuring or composting.—(*Imp. Bur. of Fruit Prod. Hort. Abs.*, Vol. VII, No. 3, p. 255, 1937. T. Eden, in *Bull. of Tea Research Inst.*, XVI, p. 20.)

CITRUS SCAB DISEASE ON GRAPEFRUIT IN TRINIDAD.

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Introduction.

In March 1937 a note was published in this Journal recording an outbreak of citrus scab disease on grapefruit in one of the Northern Range Valleys in Trinidad. Investigations were undertaken with a view to ascertaining the reasons for this outbreak, and certain interesting conclusions have now been reached.

Citrus scab disease, caused by the fungus *Elsinoe fawcettii* was until recently only known in the imperfect stage and its systematic position was in doubt. In the older literature the fungus has been placed in three genera, *Cladosporium*, *Sporotrichum* and *Sphaceloma*, but in 1936 Bitancourt and Jenkins (1) finally placed it in the Ascomycete genus *Elsinoe*. The disease is widespread in both sub-tropical and tropical regions of the old and new worlds, the earliest records coming from Japan where the disease has occurred for at least 100 years. It was probably introduced into Florida from Japan on the Satsuma orange in 1876, since when it has spread rapidly and is now common throughout the British West Indian islands with the possible exception of Montserrat. It occurs commonly on the sour orange, the rough lemon and on certain other little cultivated varieties of citrus such as the Rangpur lime. It may be very troublesome on young sour orange plants which are being raised as stocks for grapefruit or oranges, since it kills the leading shoots, and by thus promoting the growth of lateral branches, makes the production of clean straight plants for budding more difficult. Prior to 1937 this disease had only been encountered in one or two isolated instances on grapefruit in Trinidad, though it is well known on this host in Florida, Puerto Rico, West Africa and other countries. It causes considerable damage both to foliage and fruit, rendering the latter unfit for market. Losses attributed to this disease have been estimated as high as 49 per cent. of the fruit rendered unfit for packing (though such fruit may still be used for canning or in the preparation of juice) irrespective of leaf-damage, and the shedding of small fruit which is described as serious in Sierra Leone.

In Florida both the sour orange and the rough lemon are very susceptible to the disease, the grapefruit moderately so, while the sweet orange is highly resistant. In Brazil, Bitancourt and Jenkins (2) have described a variety of the fungus which attacks the sweet orange, but this disease is not known to occur outside South America. In Trinidad the sour orange and the rough lemon are both very susceptible, but until recently the grapefruit was considered to be immune or highly resistant. In certain areas sour orange trees covered with scab disease had been allowed to grow near grapefruit fields, but with the exception of one or two very mild attacks, no scab had ever been found on the grapefruit. This state of affairs is similar to that which obtained in Puerto Rico and Florida where the disease was present on the sour orange for many years before the grapefruit was attacked. Now scab occurs on the grapefruit in Puerto Rico and Florida every year and is considered to be one of the more serious diseases of the crop. The reason for the loss of immunity of the grapefruit to scab in these instances is not properly understood, but it has been suggested that it was caused by a mutation arising from the sour orange scab which was able to attack the grapefruit. Such mutations have occurred elsewhere on other crops, an example being the rust of the pimento in Jamaica which broke out so suddenly and was thought to be a mutation from the commonly occurring rust of the rose apple. The investigations which have been recently completed in Trinidad on the grapefruit scab strongly support the theory that the disease on the grapefruit is due to a mutation which has recently arisen.

Distribution in Trinidad.

In January 1937 citrus scab disease was observed on two or three hundred three-year old "Marsh" grapefruit trees in a large grapefruit estate in one of the northern valleys. A detailed survey of the area showed that of the 15,000 odd trees on this estate some 1,200 were attacked. Shortly afterwards the disease was found in a small grapefruit field in a neighbouring valley. From the age of the diseased leaves it was deduced that scab had first appeared on the grapefruit in October or November 1936. During the dry season, from February to June 1937, the disease almost disappeared, partly because of the unfavourable weather conditions which prevailed and partly because strenuous efforts were made to cut out and burn all infected material. In July 1937, however, with the advent of the rains, the disease re-appeared and by the end of the month it was as common as it had been in the previous January. Further outbreaks have occurred since whenever weather conditions have been suitable, and it seems reasonable to assume that they will continue to occur in this way. Probably, as is the case with the banana leaf spot caused by *Cercospora musae* the intensity of infection will increase until a balance is reached. During the year no further outbreaks have been reported from other parts of the island, and although spores may be carried long distances by the wind it is possible that since the infected area is to leeward of many important grapefruit estates, the spread of the disease to these estates by natural means may be slow. Moreover, the isolated situations of many grapefruit fields in large areas under other crops such as cacao, or

under forest, or in remote Northern Range valleys may also tend to check the rapid spread of the disease. The greatest risk of spreading it is through the exchange of field boxes at the central packing house, but if a system of disinfection of boxes as they enter or before they leave the packing house is maintained, this risk should be minimised. The fact must be faced, however, that if the disease persists in its present situation it will almost certainly invade other areas in the course of time.

Conditions for Attack.

Much work has been done on this disease in Florida and elsewhere by Fawcett (3), Winston (5), Jenkins (4), and others, and the conditions necessary for attack in Florida have been studied in detail. The following five conditions must be fulfilled before there can be an outbreak of the disease. Firstly, there must be a susceptible host, in this instance the grapefruit; secondly, a source of spores; thirdly, a suitable temperature (59°F. to 74°F. in Florida); fourthly, there must be moisture on the trees, or at least a saturated atmosphere; and lastly, young tissues must be available on the trees. Old lesions of the disease on the same tree or on neighbouring trees provide the source of spores which are readily dispersed by rain or wind. The Trinidad night temperature generally falls to within the limits specified above. Heavy rain is not favourable to the spread of the disease, but damp, cool, cloudy weather is very favourable. It has been demonstrated that a fairly long period of this kind of weather appears to be necessary for infection to take place, and that weather of this type is unusual in Trinidad. Only young leaves half an inch or less in width can be attacked, but fruits are susceptible from the time they are set until they are three quarters of an inch in diameter.

Meteorological Results.

Continuous records of temperature and humidity have been kept on the affected estate for a period of nine months and the incidence of scab disease on the grapefruit has been correlated to a large extent with the prevailing weather conditions. These records show that only on a comparatively few days in the year were conditions suitable for the fungus to infect grapefruit leaves and fruits. It appears that the period of eight or ten hours, when the temperature is sufficiently low and the atmosphere is saturated, which occurs on many nights in the dry season is insufficient to allow infection to take place. Spore germination is slow at all temperatures and it seems that a period of at least sixteen hours at saturation is essential for infection. The records show that such conditions only occurred four or five times during 1937, though it must be remembered that much of the year was abnormally dry, and ten to fourteen days after each of these periods an outbreak of scab occurred, depending for its severity on the amount of young tissues available on the trees. Conditions were suitable for the attack of fruit once only, most of the long wet periods occurring after the fruit had grown out of the susceptible stage. Even so, quite a large amount of fruit has been attacked and damaged.

Isolation of the Fungus and Inoculation Experiments.

The fungus was obtained in pure culture from grapefruit, sour orange, rough lemon and the Rangpur lime. The several cultures were compared with each other and were sent to Kew and Washington for comparison with cultures from elsewhere. There is reason to believe that the Trinidad 'grapefruit strain' of the fungus may differ slightly from the other Trinidad isolations. No inoculations have been made at controlled temperatures, and the exact range of temperatures at which infection can take place in Trinidad has not been ascertained, but field observations show that this range must be very similar to that described for it in Florida.

A successful inoculation technique was devised and a series of inoculations was carried out in the laboratory and in the field. Both mycelium from cultures, and spores collected from diseased trees, were used in the inoculations and equally successful results were obtained with either. The failure of several series of inoculations to 'take' was attributed to the unfavourable temperature conditions which prevailed when they were made. It was proved that under the conditions of the experiment the 'sour orange strain' of the fungus (obtained from an area where grapefruit is not attacked) could not attack grapefruit in the field or in the laboratory but would readily attack the sour orange. The 'grapefruit strain' of the fungus readily attacked grapefruit but would not attack the sour orange. It was also proved that a strain of the fungus obtained from the rough lemon would not attack grapefruit. These experiments were repeated several times with consistent results.

Conclusions.

There is strong evidence to believe therefore from the results of the inoculation experiments, from the study of fungus in pure culture and from the field observations that the 'grapefruit strain' of the fungus is a mutation from the 'sour orange strain'. The field observations do not lend support to the theory that the disease was caused by abnormal weather conditions as comparable weather conditions must have occurred many times before October 1936. It is unlikely therefore that the disease will disappear again from the grapefruit and its presence will have to be accepted. Every effort should be made to prevent the spread of the disease into other areas in Trinidad. The disease is successfully controlled on grapefruit in Florida and Puerto Rico by means of copper sprays applied at blossom-time, when half the petals have fallen. Infection is reduced in this way from 30 to 40 per cent. to less than five per cent. No effort is made to control leaf infections, which can obviously cause but little damage to the tree.

The cutting out and burning of diseased material which was tried at first in Trinidad in an effort to exterminate the disease is not to be recommended, as the removal of large quantities of young foliage probably does more damage to the tree than the fungus was doing, and moreover, does not give a satisfactory control.

In Florida, spraying against the scab disease is carried out by large power spraying machines mounted on motor trucks which drive up and down the orchards, thus covering a very large area daily. In Trinidad spraying will be more difficult and costly. To be successful the operation must be carried out during the three or four days when the flowers are at the right stage to receive the spray. The spraying and dusting experiments laid down by the Trinidad Department of Agriculture should be of considerable value in this connection, as if the disease continues to spread and to increase in intensity, as may quite possibly happen, grapefruit growers will be faced with a severe problem.

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SOIL DETERIORATION IN THE TANGANYIKA UPLANDS.

A Lesson in Tropical Agricultural Exploitation.

In the July, 1937, number of *The East African Agricultural Journal*, Mr. G. Milne, Soil Chemist at the Amani Research Station, Tanganyika, gives an interesting account* of the rapid decline of coffee plantations established by German companies in the East Usambara Highlands, situated near Tanga. This forest-clad humid mountain country, lying within easy access of an ocean port, naturally attracted agricultural exploitation soon after the German Protectorate had been set up in East Africa by international treaty in 1888. According to the customary ideas of the time, the luxuriance of tropical humid forest was accepted as signifying a very high degree of natural soil fertility, and no difficulty was experienced in accumulating the necessary capital for establishing an extensive plantation policy. Lack of agricultural labour was rectified by the importation of Javanese and Chinese coolies. At the beginning of 1902, six different enterprises were officially returned as having cleared and planted some 4,450 acres of forest land, or about 8.7 per cent. of their holdings.

The crop chosen for planting on the plateau, where the annual rainfall is some 80 inches, and the elevation 3,000 feet, was Arabian coffee which is indigenous to the African rain forest. On the lower slopes, Liberian coffee was also tried on a small scale, to be replaced either by sisal or Ceara rubber. The yield of clean coffee in 1901 from plantings four or more years old, was about 2 cwt. per acre, or ⅓ lb. per tree, but the yields gradually diminished in subsequent years. The history of the estates during the next decade may be traced in the company reports, and in the archives of the Amani Station, which was founded in June 1902, on land gifted by one of the interested firms. Already doubts had been expressed whether Arabian coffee would prove successful without careful attention to soil improvement. The view that soil deterioration may have been the cause of the early decline was hotly contested at the time by botanical and geological authorities, who attributed diminishing yields to inadequate shade, exposure to winds, the need for cover-crops and the incidence of pests and diseases. Accordingly *Grevillea* shade trees were hastily interplanted between the coffee bushes, and over large areas, alternative crops such as Ceara rubber and oil-palms, were substituted.

By 1905, the companies were explaining to share-holders that yields of coffee were unfortunately not up to expectation owing to unfavourable weather, labour troubles and pests and diseases, and that the less promising areas were consequently being abandoned. Artificial manures had been tried, but apparently without success, and hope seemed to lay mainly in the use of composts based on cattle-raising. Certain companies obtained fresh capital for planting sisal and rubber on the foothills and the coastal plain, but on quite a different kind of soil. The profits from this new venture comprised the main earnings after 1905. In 1908, it was reported in *Der Tropenflanzer* that "coffee in Usambara was shrinking more and more", and that each of the companies had been obliged to plant alternative crops. One estate had abandoned all its coffee over an area of 223 acres and had planted Ceara rubber instead, later to be changed for oil-palm. Reduction of acreage in 1904, and introduction of cattle-raising, later resulted in some cases in improved outputs. In the meantime, trial plantings of tea, cinnamon, cardamom, cinchona, camphor and Robusta coffee had been made on some of the estates and at Amani, but the planting of Ceara rubber was the main pre-occupation at that time, although the new crop failed to thrive on the old coffee clearings. The main extension of rubber planting in 1906-12 was confined to the lower altitudes.

* Essays in Applied Pedology; Soil Type and Soil Management in Relation to Plantation Agriculture in East Usambara. G. Milne, M.Sc., F.I.C., *Amani Memoirs*, 1937, pp. 1-14.

By 1914, there was little evidence that the disappointing experience with coffee had taught its real lesson, namely, that large-scale exploitation of forest land under *any* crop, without a complete revision of the old assumptions concerning soil fertility, was likely to end in financial loss.

The soil investigations undertaken at Amani prior to 1914 amounted only to a few chemical analyses and some abortive field experiments. On the other hand, field ecological surveys and manurial experiments in pot cultures, conducted between 1910 and 1917, yielded evidence of the rapid soil deterioration that follows the clear-felling and burning of luxuriant forest. It seemed reasonable to suppose that the East Usambara forest clearings provide land that is quite incapable of any form of profitable agricultural production.

At the present time the British research workers at Amani are testing a revival programme based on trials of a variety of crops, under a more rational policy of intensive soil treatment. The trial crops include cinchona, Aleurites, Robusta coffee and derris. It is hoped that greater success will be achieved under a multiple crop system than by single crop plantings, and that abandoned coffee clearings may eventually become re-occupied, so that the forest will not have been sacrificed in vain.

Soil Formation in Usambara.

The main soil-type within this region of Tanganyika is described by Milne as "*laterized red clay*", derived from the African Basement Complex of ancient metamorphic rocks, chiefly crystalline gneiss consisting essentially of the minerals quartz, potash and lime-soda felspars, biotite, hornblende, garnet and accessory apatite and pyrite. There is thus no dearth of nutrient-producing minerals, and the composition of the parent rock presents no obvious abnormality. On the Usambara plateau, the rate of rock decomposition and soil formation has more than kept pace with erosion, so that a thick mantle of mature red earth has accumulated, which has attained equilibrium with the climate and the vegetation. On the scarps, erosion has exposed a younger soil, less advanced in decomposition. The climate is very wet (annual rainfall, 80 inches), and every month has some rainy days. Long wet spells occur in April, May and June, and again in November and December. Atmospheric humidity is high, even in rainless weather. Shade temperatures in the forest show a narrow range around an annual mean of 19°C. (66°F.), the highest maximum (in February and March) being about 29°C. (84°F.), and the lowest minimum (in August), about 11°C. (52°F.). Soil temperatures under the forest floor vary between 17.5°C. and 20°C. (63.5°F. and 68°F.). The vegetation is described as evergreen forest, comprising a large number of tree species up to 150 feet high, whose shade completely excludes annual herbs and grasses. Lianes, epiphytes, shrubby undergrowths and ground ferns are abundant. Leaf litter is quickly consumed by fungi and lower animals; fallen tree-trunks gradually decompose into an acidic brown humus, and soon disappear.

The soil profile generally exceeds 6 feet in depth, the thickness of the soil-cover varying between 1½ and 10 feet. The subsoil consists of rotten rock, retaining the mineral mosaic structure of the original gneiss, but all the minerals, except quartz, are highly decomposed. The colour of the profile is a uniform brownish-yellow, brownish-orange, brownish-red or brownish-pink, rarely the full bright-red colour seen in the soils of the foothills. The constant moistness of the soil at all depths has prevented the development of bright red-coloured iron oxide produced by complete dehydration. The drainage is free and the heavy leaching has removed practically all the bases (potash, soda, lime) liberated by the profound rock weathering. Consequently the soil is highly acidic in reaction. The silica-sesquioxide ratio of the quartz-free soil ranges from 1.2 to 0.75, though its value for the younger soils is about 1.6, a feature believed to indicate a high degree of laterization, though incompleted.

The red earth contains a fair amount of "clay" (some 40 per cent.), as assessed by mechanical analysis, but its nature is such that shrinkage or drying is small, and cohesiveness is nearly absent. The soil therefore behaves as a highly permeable light loam; it is friable even when wet and highly porous, but its ability to retain chemical bases against the leaching action of percolating rain water is very poor.

Organic matter is surprisingly abundant in the topsoil, reaching nearly 7 per cent. in the surface 4-inch layer, and 2 per cent. at the 12-inch depth. Its nitrogen content also is high, carbon-nitrogen ratio ranging between 15 and 12 independently of depth. Undecomposed organic residues form only a thin skin of surface humus. The colour of the soil organic matter is very pale; hence its presence does not appreciably mask the redness of the upper profile. The humus is very acidic in reaction, and highly unsaturated by bases, although its base exchange capacity is quite high, namely about 20 milligram-equivalents per cent. The peculiar nature of this humus is thought to confer a resistance to normal breakdown by micro-organisms, so that much of its nitrogen "does not become available in the season's cycle of decomposition", and the soil does in fact, at least with annual crops, respond markedly to nitrogen.

The most striking feature of red earth soil (and one which differentiates it from many well-known soil-types of temperate countries) is that it "depends largely on the organic matter it contains for such base-absorptive power as it possesses, for the mineral colloids are for the most part non-clay in the true sense, and have little base exchange capacity of their own". "*If then we lose in cultivation that topmost 4 to 10 inches of surface soil, we have lost the part that is the principal seat of the soil's give-and-take activities.*" (Our italics in

Milne's quotation.) Herein lies the reason of the failure of laterized red earth soils to support continued cropping; their degree of permanence of natural fertility is low, and once this organic matter content is reduced to a small value, the remaining mineral material is incapable either of supplying plant nutrients or of retaining them when they are supplied as artificial manure.

In the 35- to 45-year-old clearings of the Usambara area the organic matter content of the topsoil has diminished from 7 to less than 4 per cent., and clean cultivation of the land has enhanced the loss. "Only when the period of neglect and abandonment began could the recovery make headway, for the management . . . did not provide artificial replenishment."

Relationships between Soil and Forest.

A question which has long puzzled agricultural settlers is why soils so fundamentally poor and non-retentive of nutrients (as laterized red earths) are able to maintain such magnificent forests. The answer is well-known to present-day soil investigators, and the problem is one which all tropical agriculturists and foresters should carefully study and take seriously to heart, otherwise mistakes, such as those made by the German coffee planters of East Usambara, as well as others in many parts of the world, will be frequently repeated, and the rich potentialities of virgin forest lands will continue needlessly to be wasted.

The explanation of the apparent paradox is simply that forest grows up along with the soil that nourishes it. The store of nutrients, locked up in the parent rock, is slowly made available by mineral decomposition, and taken up by the vegetation or lost through drainage. As the soil reaches maturity, during thousands of years, maybe, and a thick sterile mineral layer accumulates over the rock, the forest trees more and more "depend for their maintenance on a self-contained circulation of plant nutrient elements *via* fallen leaves, branches and trunks, through the intermediaries of decomposition, the leaching waters, the feeding roots and the stems, and so to the leaves and branches again". "The forest thus comes to depend very little on further material supplies from the reserves of the soil." "Its luxuriance is therefore no trustworthy index to the degree of fertility that awaits the agriculturist for his own very different cropping system." (Although this story has been told over and over again in other words and phrases by numerous scientific investigators, it is disappointing to note how many administrators of land policies and inventors of settlement schemes are still unaware of its teachings, and how many planters still carelessly squander the richest of Nature's gifts.)

Effects of Clean Felling and Cultivation.

During clearing, followed by burning and tillage, "the entire mobile stocks (of plant nutrients) are put into liquidation, and, as is usual at a forced sale, they go at give-away prices". The recoverable amount of this hastily-realised capital explains the early promise of the plantations. A new circulation may be substituted and set up by the crop trees, the shade trees, and by weeds and bracken, but the current funds kept in the business are altogether lower in magnitude. Value is taken out annually in the crop, but nothing is added to replace it. Leaching rapidly removes ash components left by the burning, and even the humus itself may suffer losses, partly by enhanced oxidation due to tillage and to the presence of bases from the wood-ash, and partly by surface creep and erosion. The subsoil contains little nutrient material to draw on, and favourable seasons stimulate the crop to self-exhaustion followed by dieback, and thus lower its resistance to insect and fungus attack.

Future Outlook.

The difficult problem that has to be faced in East Usambara is whether the deteriorated soils in their present state, or in any better state to which they may be brought by reasonable means, can ever support a stable productive agriculture under any crop or combination of crops. Doubtless certain economically-valuable plant species exist that might tolerate the conditions better than Arabian coffee has done. For example, cinchona has been regarded as promising from this point of view, but the successful cinchona plantations now existing immediately succeeded the newly-felled forests, whereas for future plantings, clearings 35 to 45 years old have to be considered. It must be recognised that, whatever new system is set up, its efficiency will doubtless be of a low order as compared with that of the virgin forest, for continuous losses of plant nutrients are bound to occur through leaching and erosion. It is thought that the direct addition of artificial manures is not likely to be economically successful, both for technical reasons and because of difficulties in uniform mechanical distribution. A more hopeful policy is thought to lie in the provision of grazing land in the abandoned coffee areas, which still carry their old *Grevillea* shade trees. It has been established that cattle do reasonably well on the rough pasturage, which is practically free of ticks and tsetse. Furthermore, cleared hillsides near water courses or roads carry a strong growth of grass and bracken which may prove valuable for composting. Thus, supplementary fertility may be won from land not intended for cash-crop production. Much depends in this programme on the cost of compost making, and on the economics of cattle-keeping maintained primarily for the sake of its manure. The compost heaps may provide an ideal channel through which to introduce purchased nitrogenous manure, lime and other desirable nutrient materials. Much also depends on the proper selection of suitable crops. There seems at least to be a fair prospect that, by such means as are now being tested at Amani, a proportion of the old coffee clearings in East Usambara may again become agriculturally productive.

F. HARDY.

EUCALYPTUS DEGLUPTA BLUME (*E. NAUDINIANA* F.V.M.) KAMARERE.

By R. C. Wood, M.A.

This tropical Eucalyptus comes from the island of New Britain, in the Mandated Territory of New Guinea, where it is found, under the name Kamarere, growing in almost pure stands in riverine conditions, and reaching a height of over 200 feet.

Towards the end of 1927, seed of this plant was received in Trinidad from the Inspector General of Forests, Commonwealth Forestry Bureau, Australia, both by the Forestry Department and the Department of Botany of the Imperial College. The seed was of good quality, germination was excellent, and a number of plants were obtained. Two of these were planted out on the College grounds late in 1928, and three more trees were put out near the Field Office in July, 1929; all grew rapidly. In 1936, it was found necessary to remove one of these, and as it was 12″ or so in diameter, opportunity was taken to cut some planks, from which an opinion could be obtained about the quality of the timber. A more extended planting was done in June 1936, when 100 trees, raised from Trinidad grown seed, were put out in a plantation at 15′ by 15′ planted quincuncially. These received five ounces to each tree of a mixture of 1-2-5 manure.

Almost without exception these trees have continued to grow well, as will be seen from the data given below :—

Date of planting.	Age yr.	Age mos.	Present height (feet).	Present girth at 4½ feet (inches).
October, 1928....	9	2	91	61
Do.			86	49
August, 1929	8	4	71	50
June, 1936	1	6	23±.9	8.9±.62

The two nine-year old trees are shown in the accompanying photograph (Fig. 1) and are two very handsome specimens. The plantation (Fig. 2) is also most promising.

All these trees are growing on a detrital sandy loam somewhat re-worked by stream action, derived from quartz schists which comprise the main rocks of the Northern Range of Trinidad. Its content of coarse and fine sand is about 50 per cent.: it is slightly alkaline in reaction, and contains only about 1.5 per cent. of organic matter in the surface 6-inch layer. Available potash is notably deficient (35 p.p.m. K_2O) and available phosphate slightly deficient (30 p.p.m. P_2O_5). It is very well drained, owing to gravel patches and coarse sand which are found at all depths.

Plantings made on heavier soils by the Forest Department have not shown such a rapid rate of growth. Thirty-five young trees were planted out in June 1928, but only two have survived. In June 1936, 167 plants were put out, of which 66 have survived, while a further lot of 66, raised from Trinidad seed, were planted in August 1937, partly in a swampy low-lying area, and of which at present 50 survive. Their measurements are given below :—

Date of planting.	Age yr.	Age mos.	Present height (feet)	Present girth at 4½ feet (inches).
October, 1928....	9	2	About 50′	26
Do.			,, 50′	21
June, 1936	1	6	Av. 6′, the tallest being 18′	
August, 1937	5	0	Av. 1.5′, the tallest being 3′.	

The timber was reported on by an officer of the Forest Department, as follows :—

"In June 1936, a sample board of *E. deglupta* was received. It was stacked for seasoning and in December was cleaned, planed and finished. The finished size of the board was 4′ 4″ × 9″ × ⅞″ and it had an air-dried weight of 32.2 lb. per cu. ft. The heart-wood had a maximum width of 8″ and was of a pleasant pinkish-brown colour, well figured on the tangential section. The sapwood was not very clearly defined and was somewhat streaky on the specimen submitted: this was undoubtedly due to the age of the tree and presumably the colouring would even out as the tree gets older.

The wood seasoned remarkably well, with no end splitting or surface cracking: it finished easily and well, and there was no picking up even with a softwood plane-blade setting. The wood appears sufficiently hard for flooring and general house constructional purposes, and its comparatively light weight and ease of working should make it highly suitable for these purposes."

The seed of *E. deglupta* is extremely minute but no particular difficulty has been experienced in collecting it or getting it to germinate. Professor E. E. Cheesman, the Professor of Botany at the College contributes the following note on technique which he has found satisfactory. "For germination use ordinary potting soil, only taking care to sift it very finely. It is well damped before sowing. Seed sprinkled on surface, not covered. Under *light* shade and away from wind (*i.e.*, in greenhouse), there should be enough moisture not only for germination but to serve the seedlings for some time afterwards. The essential thing is to avoid damping off, and they will do with very little water if watched to prevent complete drying out. When watering becomes really necessary, stand the box in a shallow tank and let it soak from below, (not submerged).

Photograph by *J. G. Davies.*

FIG. 1.—Eucalyptus deglupta. A nine-year old specimen.

Photograph by *J. G. Davies.*

FIG. 2.—Eucalyptus deglupta. Planted June, 1936.

A good soaking should last for some weeks again. Prick off into fresh boxes at about 2" high, and from then onwards the plants should give no trouble."

The tree, one of the very few Eucalyptus suited to tropical conditions, appears to have possibilities, and might be planted for firewood, as a windbreak, or to provide a useful timber. For the first, its extremely rapid growth would, in suitable conditions, put it ahead of the *Casuarina* which is sometimes grown for this purpose, while its rapidity of growth also makes it valuable for, at any rate, a temporary windbreak. In its own home, it is a valuable timber, indeed in a circular letter, the Inspector General of Forests, Australia, wrote in 1928: "This timber has proved the most valuable construction and general purpose timber in New Guinea and Rabaul, the capital of the territory is built of it. It makes excellent flooring and is used for every possible purpose except in the ground, where it is attacked by white ants".

RECENT IMPROVEMENTS IN INDIAN COTTONS.

By By J. B. Hutchinson.
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One of the most important characteristics of the Indian cotton crop is the wide variety of types produced. There are large and increasing crops of 7/8 inch to 1 1/16 inch cotton which would find a ready sale in any of the world's consuming countries, and there are crops of 1/2 inch to 5/8 inch staple. Fortunately, all these different classes of cotton have their own uses, and there is no likelihood that the man who "will spin anything that's longer than it is broad" will go out of business.

At first sight it is tempting to equate improvement in cotton quality to the substitution of inferior by better staples. A study of the market, and of the effect of comparatively small changes in the proportion of different types from year to year on relative prices shows that the problem is by no means so simple. Recent increases in medium staple Sind American cotton had a definite depressing effect on the premium of medium over short staples in Bombay and Ahmedabad, in spite of the fact that the new cotton was of a type readily saleable in overseas markets.

The problem is really two-fold. First, it is necessary to strike some sort of balance between the crops of different staples and spinning properties, and secondly, having agreed that a range of types must be grown, mixing of staples and the adulteration of high priced with low priced types must be prevented.

The second part of the problem was attacked first, partly because it was easier and partly because it was obvious that any attempt at adjustment in the proportion of different staples would be stultified unless the problem of adulteration were first taken in hand. The most important factor in the recent improvement in Indian cottons has been the Cotton Transport Act, which was passed in 1923. Under this Act, Provincial Governments are enabled to schedule tracts growing superior staples as "Protected Areas". The import of cotton into a "Protected Area" is prohibited except under licence for legitimate consumption. Protected Areas have been established in various parts of the Bombay and Madras Presidencies, the Central Provinces and Hyderabad, Rajpipla, and a few other Indian States. The cottons protected are chiefly American Uplands (Cambodia and Dharwar American), high quality *herbaceums* (1027 ALF, Kumpta and others) and superior types of *G. arboreum* var. *neglectum* forma *indica* (Bani, Karunganni, &c.). Where only one type of cotton is grown in the Protected Area, prohibition of import has been highly successful in ensuring that the produce of the area is sold unadulterated. Unfortunately, many tracts produce two or more types of cotton of widely different quality. In parts of the Cambodia protected areas in Madras, Karunganni and Uppam cotton are also grown, and while Karunganni is a staple cotton, Uppam is not, and the two are frequently grown mixed in the same field.

There are no Protected Areas in the great northern cotton tract in the Western United Provinces, the Punjab, and Sind. Apart from C402, the future of which is doubtful, the United Provinces have not yet got a cotton sufficiently superior to the average to be worth protecting. In the Punjab and Sind, American and *desi* (indigenous) cottons are grown side by side, and there is naturally nothing to be gained by prohibiting the import of coarse indigenous types when they are already grown there on a large scale. In Sind an attempt is being made to reserve a large block of the new irrigated tract for staple cottons only (American, Egyptian, and Sea Island), but considerable difficulty has been encountered, as the coarse *desi* cotton is a safer crop, and when the premium for quality is low, its higher yield ensures a greater return per acre than is obtainable from American.

It is concerning tracts where cottons of different quality are grown side by side that the most persistent complaints of mixing are made. In the Central Provinces pure Verum cotton is bought, ginned and marketed by the Verum marketing pool, but the pool handles only a small proportion of the Verum grown, and a very large amount of that sold through ordinary trade channels is mixed with the inferior Roseum. In the United Provinces, the produce of the areas where pink bollworm is controlled, though of the same spinning value as that of uncontrolled areas, is vastly superior to the latter in grade and colour. Buyers in Cawnpore say that it is never available on the market, and ginners in

the controlled areas complain that they are losing their trade. The clean seed cotton is bought and shipped outside to be ginned with infested material to raise it to a more readily saleable grade.

In the Punjab and Sind a rather different mixing problem exists. Buyers actually demand a mixture, and contracts are placed with ginneries for mixtures containing specified percentages of *desi* cotton. As it is impossible to determine accurately the percentage of the two types after mixing, there is considerable inducement to fraud.

As an aid to the control of malpractices, especially of mixing in tracts where two types of cotton are grown side by side, the Cotton Ginning and Pressing Factories Act was passed in 1925. Under it, ginnery owners are compelled to maintain complete ginning reports at their factories, and press owners have to number and mark their bales and maintain a register of the bales pressed, with their marks and ownership. A bale against which a complaint is made can be traced back to the press and in cases of fraud proceedings can be taken against the original owner. The Ginning and Pressing Factories Act put in the hands of the trade the means to set its house in order, and there is no doubt that there has been a great all-round improvement as a result. Staple cotton has been kept purer, and the reputation of short staple cotton tracts for sound cotton has improved. Much remains to be done, however, and opinion is divided on what should be the next step. Some wish to take the drastic step of prohibiting all mixing, but at present this seems impracticable. Unless trade opinion is almost unanimously behind it, it would be unworkable, and in many cases crops are being grown from mixed seed. Unless adequate pure stocks of seed are made available and distributed to the whole controlled tract, considerable quantities of cotton mixed in the field will be offered at the ginneries. A possible interim step is to put a mark on the bale indicating its composition, but both the trade and the Governments concerned are rightly reluctant to require information which cannot be accurately checked by fibre analysis.

If the recent improvement in the standard of Indian cotton is to be carried further, the Indian cotton trade must recognise that they are responsible both for the present state of affairs and for devising methods to improve it. Government can only act when the trade is agreed, and legislation only works in so far as the trade makes it work.

To summarise the present position, reliable cotton, up to the standards of its growth, up to sample, and even running, is available in all the growths of the country in greater quantity than ever before. The fundamental legislative measures for its protection have been taken, and are working well, and the responsible elements of the trade are working for better control and a higher standard of trading. Complaints are still made of Indian cotton, and malpractices still exist, but with good cotton readily available, those who have been unfortunate may be recommended to change their suppliers and not their source of supply.

Efforts to control the balance of production of different staples of Indian cotton have up to the present been confined to attempts to increase the proportion of staple cottons (7/8 inch and above.) There is no doubt that the proportion of staple cottons in the Indian crop is well below what it might be, and the recent trend in consumption both in Indian mills and by India's customers overseas has been towards a larger proportion of better quality cotton. There is normally only a small exportable surplus of staple cotton, and Indian mills import considerable quantities of United States and Uganda Upland cottons and some Egyptians and Sudan Egyptian also. Progress has been most marked in Madras, where the extension of Cambodia has had a profound effect on the South Indian mill industry, the Central Provinces, where the introduction of Verum cotton has established staple cotton in the areas which once produced fine Oomras that a century ago would sell against good New Orleans, and in the Punjab and Sind, where the extension of irrigation and the work of the Agricultural Department have combined to make possible the production of a large crop of good quality Punjab American. In Bombay the change, though considerable, has been less spectacular. Bombay never lost her staple cottons as did the Central Provinces, never gained an important new introduction, as did Madras, and was not able to increase her cultivated area in the way the Punjab and Sind have done.

One-third of the Indian crop is now staple cotton, and the question arises, how big a proportion should be aimed at? Only a small proportion of the Central Provinces and Berar crop is Verum as yet, and the introduction of staple cottons into Khandesh has hardly begun. With the control of pink bollworm which is now being undertaken in the United Provinces, another large area will become a potential producer of staple cotton, while the breeding of "Jubilee" cotton from a cross between a Chinese cotton and Punjab Mollisoni opens up possibilities of substituting staple types for the Punjab *desi* short staple crop. Trade opinion varies according to the state of the market. With abundant supplies of staple cotton and strong Japanese demand for short staple, business men are apt to call a halt to the breeding of finer types, while the end of a Japanese trade agreement or a short crop of staple cotton can be relied upon to induce an insistent demand for new staple varieties. Unfortunately, an Agricultural Department must judge the demand over a period of years, and conditions have changed so rapidly and so frequently since the War that it is difficult to come to any conclusion. There appears to be no need to force the production of staple cotton, but in the large tracts which once produced it, and lost it, in the early decades of machine ginning in India, it can be re-introduced safely and profitably.

THE USE OF MOLASSES AS A MANURE.

By R. C. Wood, M.A.

[*This note is based on the dissertation submitted by G. D. Badger*, B.Sc., A.I.C.T.A., *in part requirement for the Associateship of the Imperial College of Tropical Agriculture*, 1937.]

Although molasses is used regularly in various parts of the world as a manure for sugar cane, as in Queensland (1) and Mauritius (2), and has been tried in Trinidad and St. Kitts by Turner (3, 4) little is known of its possibilities for other crops, with the exception perhaps, of rice in Java and in British Guiana, where it has attained a rather uncertain measure of success (5).

The increase in sugar production in Trinidad, and the decreasing use of stock for cultivation purposes, makes the profitable disposal of the molasses at times a matter of some difficulty, and the present note describes the results obtained from an experiment in which it was used as a manure for maize and sweet potato.

The results of the experiment with maize are given in Table I.

The figures in columns 1 to 5 were obtained from pre-harvesting studies, and show that at first, the molasses had a very definite depressing effect. Germination was delayed. The young seedlings were smaller and lighter, and this is shown in column 3 (*a*), which is an estimate made of the appearance of the plots by a disinterested observer, and in 3 (*b*), which is calculated from the weights of the seedlings removed when the crop was singled. The mature plants were shorter, and finally, flowering was delayed, as can be seen from the figures in column 5. In spite of these early handicaps, the differences in yield of grain are inconsiderable, owing to an increase in cob-weight which helped partly to make up for the lower cob-number.

The conclusion to be drawn from these figures is that in these circumstances, the molasses has had absolutely no effect on the final yield, as a result of equilibrium being held between a depressing influence at the start and a stimulating influence later.

Besides these two applications of molasses, the experiment included the use of a complete well-balanced mixture of mineral manures, which was used alone and in combination with the molasses dressings, while a sub-treatment tested the value of sulphate of ammonia, applied at the rate of 1 cwt. to half of each plot.

It may be said briefly that though an increase of 13 per cent. in weight of cobs was obtained by the use of sulphate of ammonia, of 17 per cent. by the use of the balanced artificials, and of 27 per cent. by their combination, these figures were lowered when the manures were used in combination with molasses, to −1.5 per cent., 8 per cent., and 21 per cent.

The experiment on sweet potatoes followed the same lines except that sulphate of ammonia was not used by itself. The results of the molasses treatment are shown in Table II.

Table II.—*The Effect of Molasses on the Sweet Potato Crop.*

Treatment.	1. Estimate of haulm growth.	2. Weight of tubers.	3. Weight of marketable tubers.	4. Weight of haulms.
Control	100	100	100	100
5 tons Molasses	**133**	118	123	**116**
10 tons Molasses	**140**	114	117	**129**

Eight replications : plots 1/53 acre.

The control crop yielded at the rate of 6,730 lbs. an acre. All figures are shown as percentages of the control.

Table I.—*The Effect of Molasses on the Maize Crop.*

Treatment.	1. Germination count Dec. 24.	2. Germination count Jan. 1.	3. Seedling vigour. (a)	3. Seedling vigour. (b)	4. Height.	5. No. plants not tasselling.	6. No. of cobs.	7. Wt. of cobs.	8. Wt. of straw.
Control	100	100	100	100	100	100	100	100	100
5 tons Molasses	93	97	**67**	**43**	91	**177**	87	96	121
10 tons Molasses	81	95	**44**	**28**	85	**257**	80	88	124

Six replications : plots 1/40 acre.

All figures are shown as percentages of the control. Figures in heavy type are significant at the 5 per cent. point. Figures underlined are significant at the 1 per cent. point.

The molasses was more successful with sweet potatoes than with maize, and the plots receiving molasses showed themselves ahead of the control, right through their growth, though actually the increased yields of tubers do not possess statistical significance. An application of artificials equivalent to the manurial constituents of the molasses, has, in this case, had rather less effect than the molasses, but again, the differences were too slight to have any significance.

The results of these two experiments are not encouraging. The land on which they were conducted was in too good heart for any very definite result to be given either by molasses or artificial manures, but it is clear that in some way molasses has an actually depressing effect, though this is not lasting. The molasses was applied to the maize plots from only a couple of days before sowing, and it may be that this period was too short, although in preliminary trials it was shown that there was no difference between molasses applied one or two weeks before sowing, or actually at the time of sowing, to a crop of *Phaseolus Mungo*. In the case of the sweet potato experiment, the interval between application and planting was a week, but in this case, the land was ridged up after the application of molasses, and thus aeration was ensured: the maize crop was sown on the flat.

An objection to the use of molasses is the difficulty of applying it to the land quickly and cheaply. For experimental purposes, it was found best after various trials to use two perforated kerosene tins, slung on a rod and carried by two men, and filled up by buckets from a cart. More satisfactory measures could of course be adopted where distribution is to be done on a large scale.

Two other points may be noted about the effect of using molasses. It increases the permeability of the soil, and this point was very clearly brought out when a sharp shower fell on the experimental field shortly after the molasses had been applied. Water lay on the surface of the untreated plots, but rapidly disappeared from the plots treated with molasses, and a careful estimate of the area of standing water showed differences of 68 and 80 per cent.

Table III.—*The Effect of Molasses on Weeds.*

	Control.	5 tons.	10 tons.
		SWEET POTATO.	
Weed estimation	100	**30.9**	**31.8**
Weight of weeds	100	**59.3**	**34.5**
Weed estimation		MAIZE.	
1st ...	100	**15.7**	**18.6**
2nd ...	100	**23.4**	**19.1**
3rd ...	100	71.4	56.0

Finally there is the reaction of molasses to weeds, on which it has a definitely depressing effect. This was shown by estimates made in the different plots by impartial observers; they gave results which were highly significant.

Molasses thus acts as a considerable check on weed-growth, but the figures in the maize experiment show that this effect is not lasting.

The following conclusions may be drawn from the experiment :—

(1) In the conditions of high fertility prevailing in the experimental area, nothing was gained by the use of applications of 5 or 10 tons of molasses to the acre, to crops of maize and sweet potato.

(2) In view of the difficulty experienced in applying molasses to the soil and its negative results, it does not seem likely that it will ever be an economic manure.

(3) The addition of molasses to the soil induces a condition temporarily toxic to plant growth, and therefore destroys weeds.

(4) The addition of molasses to the soil brings about a change in soil texture, making it more open and porous.

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GINGER CULTIVATION IN JAMAICA.

The clay lands are forked and left to dry three months before planting and a month before planting again forked and drained by means of trenches. The plants consist of pieces of the rhizome from the old crop then being dug. These are supposed to produce "bolder" and therefore higher priced ginger if left to cure for a month before planting and for this reason June rather than April or May is claimed to be the best planting time. The bits are placed 9 inches apart in furrows 9 inches deep. 1,500 planting bits are used per acre at a cost of 8s. per 100 lb. Smaller bits may be used in fertile soil. Whether planted early or late the crop will be ripe during February or March of the following year and is ready for lifting when the foliage has dried up. Ginger should be grown in full sun, shadegrown ginger having a tendency to shrink when cured.—(*Imp. Bur. of Fruit Production, Horticultural Abstracts*, Vol. VI, No. 4, Abs. 913, p. 317, 1936. J. A. Graham in *Jr. of Jamaica Agr. Soc.* XL. pp. 231.)

COFFEE SELECTION IN THE NETHERLANDS INDIES.*

By Dr. C. J. J. van Hall.

In the matter of selection of perennial crops, such as coffee, rubber, cacao, cinchona, kapok, tea, the initiative was taken and most of the pioneer work has been done in the Netherlands Indies.

Selection of coffee was started some twenty-five years ago. Planters had indeed made a few feeble efforts before that time to improve their crops by selecting what they considered to be the best planting material, but their methods were inefficient and it was only after the Department of Agriculture and the Experimental Stations had taken the matter in hand and based selection on scientific principles that the work was carried on in a manner which promised satisfactory results.

The species mainly used in these selection experiments was *Coffea robusta*, which is the species most widely cultivated in the Indies at the present time. The once famous Arabian coffee (*Coffea arabica*) from Java, generally known to the trade as "Java coffee", has lost its commercial significance. During the 19th century it held first place as a product for export. About the middle of that century more than a million piculs (roughly 60,000 tons) was exported yearly. Then it fell a victim to coffee-leaf disease. This pest spread from East Africa all over Asia, devastating coffee plantations in Ceylon, where it appeared in 1867, and in Sumatra and Java, where it was first noted in 1876. No really practical means of controlling this disease has as yet been discovered. Planters simply had to abandon the cultivation of *arabica* and replant their fields with other crops. At present not more than some 7,000 tons of "Java coffee" are exported yearly and the greater part of this comes from native plantations.

Between 1880 and 1900 much was expected from Liberian coffee, which had been imported by the Government in 1876. But this species, though it seemed at first immune to leaf disease, also fell prey to this plague after a while, and gradually the fields became bare once more.

In 1900 another species, new to the Indies and so far unknown, was imported from West Africa and named *Coffea robusta*. It appeared to be much more resistant to leaf disease than Arabian and Liberian coffee and it soon became popular on the estates as well as among native farmers. Larger and larger crops of it were cultivated year by year, until at present it constitutes a most important product, the estates, especially in Java, producing more than 55,000 tons yearly and the native farmers, particularly in Sumatra, about the same quantity. About one-third of this quantity is consumed locally and roughly 80,000 tons are exported.

Like so many of our tropical crops this *C. robusta* is a heterogeneous mixture of a number of strains and any given plot will contain trees presenting widely divergent characteristics. For this very reason it may be regarded as an excellent object for experiments in selection. This work has been taken up by the Bangelan Government Coffee Estate, the Central Java Experimental Station in collaboration with the Banaran Coffee Estate, the Malang Experimental Station(1), and finally the Besuki Experimental Station at Djember.

The method first pursued on the Bangelan and Banaran Estates is generally called "mother tree selection". It may be briefly described as follows: 1. Selection of mother trees showing superior qualities. 2. Propagation of these trees by vegetative reproduction (grafting) or by seed. 3. Testing of the offspring, both grafts and seedlings.

The first mother trees were selected at Bangelan by Dr. P. J. S. Cramer in 1907 and at Banaran by Caesar Voûte in 1911. This work is less simple in the case of coffee than in that of other crops. The productivity of the mother tree is the first thing to be studied, but other qualities have to be considered as well, especially that of resistance to diseases and the size of the bean. Much painstaking and carefully supervised work has to be done before reliable information can be obtained regarding the productivity of the mother trees and the whole process has to be repeated, and the same difficulties faced, when the offspring of these mother trees have to be tested in their turn. The laboriousness of the work involved accounts for the fact that coffee selection has not become as popular with the planters as has, for instance, the selection of rubber. In the case of rubber the procedure can be combined with the ordinary work on the plantation without causing very much extra trouble, but this is not the case with coffee.

Seedlings as well as grafts were used in studying the progeny of these mother trees. Grafts present obvious advantages: in their case there is only a mother tree involved and no father tree. Hence the progeny are uniform, being absolutely identical with the mother plant, at least in their hereditary characteristics. It is this fact which has led to propagation by grafts or cuttings or buds—vegetative propagation, as it is called—being the method generally adopted in the cultivation of most of our fruit trees and many of our ornamental plants. To have the plants uniform is a great advantage on a coffee estate when it comes to picking; for this means that the difficulty of having early bearing trees interspersed with late-bearing ones is avoided. Uniformity of the beans also makes preparation of the product for the market simpler. A further advantage of grafts is that, when we are obliged to deal with soils infected with eelworms (*nematodes*), they can be successfully grown on resistant seedlings as stock.

* Reprinted from *Bulletin of the Colonial Institute of Amsterdam*, Vol. I, No. 2, pp. 135-143, 1938.

(1) A few years ago the Central Java Experimental Station and the Malang Experimental Station were combined and became the Central and East Java Experimental Station.

But grafts have also drawbacks. A coffee tree can produce only a very limited number of grafts each year and therefore propagation proceeds slowly. Also, the grafting technique complicates plantation work materially. Again, the stock may influence the qualities, and especially the yield of the graft, which makes the selection of the right stock a problem in itself.

The above considerations led experimenters to conclude that for testing the progeny of selected mother trees it was advisable to make use of both the vegetative and the generative methods of propagation.

The first experimental plots of grafted trees—each plot containing only the grafts of a single mother tree and thus representing a single clone (1)—were planted on the Banaran Estate in 1915 and at Bangelan in 1916. At Banaran there were 32 plots each carrying 25 trees. At Bangelan each plot had 16 trees. The number of selected mother trees at Bangelan has since much increased and now there are more than 500 experimental plots of 16 trees each under observation there.

As in the case of rubber, these experiments showed that only a few of the many trees selected for their high productivity produced offspring with a high yielding capacity. Many clones had to be discarded as not up to standard, or entirely worthless, and only a very small percentage was kept as being really superior.

When for the purpose of further study, larger plots of these high yielding clones were planted, a remarkable and at first disappointing fact was observed: the yield per tree proved to be considerably less than that obtained from the smaller plots. The clue to the situation was found when the biology of the flower was studied and the fact emerged that most clones are better adapted to cross-pollination than to self-pollination, in other words, trees of one clone are, generally speaking, most productive when fertilized with pollen from trees belonging to another clone. Not all clones behave alike, however, in respect to this matter of pollination. Some produce practically no seeds at all when self-pollinated, others—the majority—produce a small or mediocre yield when self-pollinated, but show a much higher degree of productivity when cross-pollinated. A very few yield satisfactorily whether cross or self-fertilized (2).

The fact that almost all clones give a somewhat higher, or even a much higher yield when cross-pollinated has led planters to avoid planting large plots with a single clone. The general practice is to combine two or more clones, which have yielded satisfactorily when inter-crossed. A great deal of laborious experimentation was required to find these combinations. But the work has now progressed to the point where we may say that the really fruitful combinations of our best clones have been determined (1).

After the combinations had been determined another problem arose, namely, what is the best method of inter-planting? It was impossible to answer this question without first inquiring how pollen is carried from tree to tree under natural conditions. Until recently no one knew what rôle insects and the wind played in the fertilization of these plants. But investigations made of late years have shown that in a coffee plantation the number of insects that could possibly play a part in the fertilization is so inconsiderable that it is safe to say without further investigation that pollination of our *robusta* does not take place through their agency. Remains, then, the wind and it was J. P. Ferwerda's interesting experiments that taught us many facts regarding the details of the process. Glass plates were set up at different distances from coffee trees in bloom and covered with some sticky substance. It was then discovered by the deposits on the glass that a moderate wind will carry the pollen as far as 100 metres and raise it to a height of at least eight metres. The results thus obtained put the question of interplanting on a stable basis.

As already mentioned, it is by no means a matter of indifference in the case of *C. robusta* what stock is used for grafting. Some 20 years ago, when selection work was still in its infancy, it was thought that *C. excelsa* was the ideal stock for *robusta* grafts. Later, preference was given to *robusta* itself as a stock. But it has now been proved that both species contain strains which make them suitable for use as stock for *robusta* clones. It has also become apparent that seedlings belonging to the same species as the scion do not by any means always produce the best results as stock (2).

These results, obtained by much painstaking and difficult work in experimental gardens, are very encouraging, but we may not base direct

(1) "Clone" stands for all the graft-descendants of one tree collectively.

(2) To quote an instance or two: self-fertilization produces poor results in clones R.Bgn. (short for *robusta* Bangelan), 300, 325 and 340; mediocre results in R. Bgn. 83-03, 105-04, and 525, and satisfactory ones in the case of R. Bgn. 371 and 121.

(1) For example, the above mentioned Bgn. 105-04, one of our most promising clones, yields successful results when pollinated with Bgn. 83-03, 300 and 325, or with *Quillou* Bgn. 121; Bgn. 300—also a very promising one—combines satisfactorily with Bgn. 105-04, 325 and 372.

(2) Seedlings of clone Bgn. 124-01 are very good stock for most of our *robusta* clones. They have also proved to be good stock for *C. congensis*, *C. excelsa* and *liberica* × *arabica* hybrids. One of the *Quillou* clones, namely, *Quillou* Bgn. 121, also produces seedlings that are suitable for use as stock for most of the *robusta* clones. (*Quillou* may be considered a variety of *C. robusta*.) The same may be said of SA 109, a clone from the Expt. Garden "Sumber Assin", one of the *canephora* clones (Madagascar 3 Bgn.) and two *excelsa* clones (Bgn. 121-04 and 121-10). For some of the clones the yield figures obtained from the experimental plots are very satisfactory. At Bangelan, for instance, in some fields Bgn. 104-105, 300 and 124 gave about double, or almost double, the average yield of ordinary seedlings.

conclusions on them as to the value of any given clone when planted on other estates. For experiment has shown that the behaviour of each clone varies with soil, climate and cultivation. For this reason the Experimental Stations always advise planters to make trial plots of more than one selected clone, for each planter has to find out for himself which clones produce the best results on his particular estate.

On the Banaran Estate selection work was carried on by Caesar Voûte, the manager of this estate, along the same lines as those pursued at Bangelan. But here there was no opportunity for research work and the selection had to be done in accordance with the kind of routine which could be followed on other estates as well. Some promising clones were obtained, as for instance Banaran Nos. 4 and 7.

At Sumber Assin, the coffee garden of the Experimental Station at Malang, the selection was done by Dr. Hille Ris Lambers of the Central and East Java Experimental Station. Results obtained there corroborated the view obtained at Bangelan that most of the *C. robusta* trees or clones are "self-incompatible", *i.e.*, give very little fruit when self-pollinated, and at this station as at Bangelan data were collected bearing on the problem of how to combine father and mother trees so as to obtain the most fruitful pollination (1).

Very satisfactory results have also been obtained at the fourth institute which has taken up the selection work, namely, the Besuki station at Djember in the most easterly part of Java (2).

Some private estates have begun to follow the example of the experimental stations, selecting a number of mother trees and planting plots of grafts from these for experiment and study. Mention should be made in this connection of the Kalisanen estate and the clones grown there, one of which seems particularly resistant to drought.

In the foregoing we have considered only the grafted offspring of mother trees, the clones. But it has been doubtful from the first whether "vegetative" propagation (by grafts in the case of coffee) or "generative" propagation (by seeds) would prove the more successful, and at both Bangelan and Banaran the two methods were tried. This "generative" selection has proved to be another very large field calling for laborious investigation.

During the first few years of selection work at Bangelan, seeds were gathered from the mother trees without pollination having been controlled in any way. The offspring thus obtained was by an unknown father. At Banaran another method was followed. Here an effort was made to produce seeds by self-fertilization of the mother trees. The advantages of self-fertilization are obvious namely, that in the case of seeds produced by this method the superior mother tree becomes also the superior father tree and the trouble involved in artificial crossing is avoided. In order to achieve this self-pollination mother trees or branches thereof were put into cages made of mosquito-netting. The number of seeds obtained in this way was, generally speaking, small—very small indeed, in some cases. Since we have learned that many *robusta* trees yield only a small quantity of seed when self-pollinated, this result no longer surprises us.

It must not be supposed, however, that the quantitatively disappointing yield produced by self-fertilization necessarily involves seeds that will bring forth weakly or low-yielding trees. In a number of different cases "seedling families"(1) obtained by self-pollination have proved to be excellent and have, some of them, won excellent reputations among the planters. At Bangelan several such families were produced. These are not, like corresponding ones at Banaran, the descendants of single trees but of monoclone fields. Most of these fields are about two and a half acres in size, and hence the berries from trees in the middle of the plot are practically all the product of self-pollination.

Artificial crossing has also been used to produce a large number of "families". These have been kept under observation, each on its own plot, exactly like the clones or grafted offspring. Of these also the majority had to be rejected, but a minority produced seedling families that excelled in yielding capacity or in some other respect, or occasionally in all respects. Some families were quite uniform, others very heterogeneous.

It is hardly necessary to say that the testing of the seedling families requires the same laborious care as the testing of the clones. Many different plots have to be kept under observation for a number of years before a reliable impression can be obtained about their productivity and other characteristics (2).

In the foregoing only *C. robusta* has been dealt with and this species is indeed the one which has been mainly studied. But it is not the only one to which scientists have devoted attention. The institute at Bangelan has always regarded it as one of its most significant tasks to import new species and varieties from other countries. This work was started as early as 1905 by Dr. P. J. S. Cramer and it has been done so successfully that at present this station possesses a collection of different species of coffee which is quite unique. Some of the most promising of these imported species have been used for inter-crossing and selection. A few of them may be mentioned here.

(1) We may note SA 13, 56 and 109 as high yielding clones obtained at Sumber Assin.

(2) Of the clones here obtained BP 39, 42 and 56 deserve special mention.

(1) The word "family" has been adopted to designate the whole of the offspring of a given father and mother tree.

(2) The following seedling families obtained by self-pollination deserve special mention: Bgn. 105-01, Bgn. 119-2, Bgn. 202; good families resulting from cross-pollination are: Bgn. 105-04 × 83-03, Bgn. 300 × 105-04, and SA 113 × 129. In these last designations the sign × means "pollinated by". Thus SA 113 × 129 indicates a family which is the product of SA 113 as mother tree and SA 129 as father tree.

Coffea congensis is the small-leaved species which possesses the great virtue of being practically immune to the coffee-leaf disease but yields very poorly. It has produced hybrids by pollination by Uganda coffee, a variety of *robusta*. These hybrids have been given the name of *conuga*. Different *conuga* strains, descendants of selected mother trees, are at present under observation, and several of the clones and seedling families seem quite promising. The *quillou* variety of *robusta* is very productive on some soils. *Quillou* Bgn. 121 may be mentioned as one of the superior strains. At Sumber Assin some good strains of *C. canephora* have been obtained. This species is closely allied to *robusta*. The newly imported and little known *kapakata* coffee has also been used for inter-crossing.

In 1920 the Besuki Experimental Station took up the selection of Arabian coffee. What the scientists hope to achieve is the development of a pure *arabica* strain, more or less resistant to leaf disease and suitable for cultivation in regions where at present this is impossible, but the ideal they are striving for is still far from being realized. For, as a matter of fact, no tree with notably less than average liability to leaf disease has yet been found. Another subject scientists have in view is to obtain a hybrid between Arabian coffee and some resistant species which shall combine some of the fine qualities of the Arabian with a certain resistance against leaf disease. At Sumber Assin hybrids were obtained by pollination of *arabica* coffee with *C. laurentii*, and one of these, Arla 1, seems promising. Hybrids have also been produced by crossing *C. arabica* and *C. congensis*.

Twenty years is a short time for selection work, especially when dealing with a perennial crop, and we have not yet come to the point where we can claim that the Experimental Stations have ready to hand clones and seedling families to suit the exact needs of any and every estate that may apply for advice and assistance. But for all that there is reason to look with satisfaction on the work so far accomplished. Thanks to the arduous and expert labours of different scientists there is a number of excellent clones and seedling families available for planters to use as a basis for the individual experiments, which each must inevitably make for himself on his own particular estate in order to discover which of various promising strains is best suited to the special conditions he has to offer. Planters have come to realize this and one may say that it is now the general custom with them to avail themselves of the selected material offered by the various institutions mentioned in the course of this article.

THE ETHYLENE TREATMENT OF TOBACCO.*

THE effect of very small quantities of ethylene on the ripening (colouring) of fruits is well known, and this gas is now being employed on a commercial scale in the United States, the Union of South Africa, and elsewhere, particularly in connection with citrus fruits. The effect of the gas on the ripening of fruits is recognised to be due to stimulation of the enzyme process, and, since the changes which take place during the curing of tobacco are also related to enzyme action, it has been suggested that the quality of the leaf might also be favourably influenced by the action of ethylene. Hitherto, not much work has been done in this direction, but the matter has been taken up by the Agricultural Adviser to the Colonial Office, and arrangements are being made for experiments on the gas treatment of tobacco to be carried out in certain tobacco-producing countries in the Empire. For the benefit of those concerned with such experiments, the Imperial Institute has prepared summaries of two papers dealing with work on these lines which has already been done in Germany and Italy, and these are printed below. The results of the German experiments are recorded in a paper by Dr. G. Pfüster and Dr. H. Losch, published in *Die Umschau*, Vol. 39, No. 11, 10th March, 1935, pp. 202-206. The authors undertook experiments with tobacco, primarily with a view to ascertaining whether a good ripe yellow colour could be obtained with certainty by means of very small quantities of ethylene or acetylene. They found that the ripening of tobacco could be accelerated by the same substances as are effective in the case of fruits, and that these include, in particular, "narcotic" gases, such as ethylene, acetylene, and nitrous oxide. These gases can be used in very high dilution, *e.g.*, ethylene, in the proportion of 1 in 1,000, or 1 in 100,000, or in some cases 1 in 1,000,000 parts of air, has a definite effect on enzyme action in plant cells. Such minute traces obviously can have no deleterious effect on the tobacco or on the health of the smoker. Their action may be regarded as similar to that of an activator in catalysis.

In the authors' experiments, ethylene-air mixtures in the proportions 1 in 5,000 to 1 in 10,000, were generally employed; sometimes rather more concentrated acetylene-air mixtures were used.

In order to carry out tests, the freshly-gathered leaves were divided into three portions, two of which were placed in airtight chambers into one of which the gas was admitted, whilst the third went into the tobacco shed. Conditions in the two chambers were the same, temperature being between 20°C. and 25°C., and atmospheric humidity about 90 per cent. They were "aired" each day to remove carbon dioxide which would retard the ripening process, a fresh dose of ethylene being admitted each time to the treatment chamber. Later an arrangement was devised for removing the carbon dioxide continuously by means of a rotary pump and suitable absorbent materials, this having the additional advantage of ensuring circulation in the atmosphere of the chamber.

* Reproduced from the *Bul. of the Imp. Inst.* Vo. XXXV, No. 3, pp. 359-63, 1937.

It was found that, in the case of leaves picked at the normal time or eight to ten days earlier, those treated with gas showed a yellow colouring earlier and more strongly than those in the other chamber, the leaves in the tobacco shed being the slowest to show yellowing. Leaves that had been picked three weeks before the normal time would not develop a good yellow colour, even in the gas chamber, but turned to olive-green or brown tints.

Tests of treated and untreated tobacco (after fermentation) for smoking qualities (flavour and aroma) showed very marked superiority in the case of the treated material. Thus the flavour of an untreated sample was described as "sharp and poor", and its aroma as "not quite pure", whilst in the case of the corresponding treated material the flavour was pronounced "rather full, not unpleasant", and the aroma "pure, somewhat flowery". The "character" of the tobacco in respect of those qualities that determine its graduation from "heavy" to "light" was in general unaffected by the gas, though in some cases it was rendered definitely "lighter".

The influence of ethylene treatment on nicotine content was found to depend on its duration, the first effect being to produce an increase, but the final result being a decrease. The authors do not attempt to correlate smoking qualities and nicotine content, but state that the greatest improvement in quality by gas treatment did not coincide with the maximum reduction in nicotine content.

Experiments were also carried out in exposing the leaf to ethylene during fermentation, the gas being introduced either in one dose or in successive doses at intervals of a few days. The treatment had a markedly favourable effect on the flavour and aroma of the tobacco, which were described respectively as "pure and full" and "pleasant, somewhat flowery" whilst the corresponding reports on untreated tobacco were "rather unpleasant and poor" and "rather impure." It thus appears that gas treatment during fermentation is as advantageous as that of the freshly gathered leaves.

The effect of prolonged gas treatment was tried with a view to ascertaining whether it would be possible by this means to dispense with fermentation. Leaves exposed to ethylene (1 in 5,000) for six months and not fermented were actually judged more favourably as to smoking qualities than untreated but fermented leaves. In practice, treatment requiring such long duration would not show any advantage over fermentation as ordinarily carried out, but the result is regarded as theoretically interesting.

Finally, the authors find that even finished tobaccos, *i.e.*, pipe tobacco, cigarettes, and cigars, especially those of poor quality, may be improved in aroma and flavour (if only to a very moderate degree), by gas treatment, showing that the activity of the enzyme is not quite destroyed even in tobacco that has been fermented, heated, and dried in storage.

The results of preliminary experiments carried out by Dr. U. Rossi in Italy are described in the *Bollettino Tecnico del R. Istituto Sperimentale per le Coltivazioni dei Tabacchi "Leonardo Angeloni", Scafati (Salerno)*, Vol. XXX, No. 4, October-December, 1933, pp. 221-258. The author states that ethylene gas, at suitable dilution and under proper conditions of temperature and moisture, exerts a stimulant action on tobacco leaves, resulting in a considerable acceleration of the various changes that follow their harvesting Trials made with a number of different varieties of tobacco showed that the time necessary for curing may be reduced by about 40 per cent. He claims that ethylene treatment improves the aroma, colour, and burning qualities of tobacco. The gas does not itself enter into any chemical combination in the leaf, nor does the treatment lead to any secondary reactions having adverse effects on the finished product.

It is pointed out that the process is not only advantageous for improving the quality of poor tobacco. In the case of highly priced oriental tobaccos, the youngest leaves of which do not reach maturity at the required time, the ethylene treatment of these leaves, provided they have attained a sufficient degree of development, will bring them to maturity and enable them to be cured satisfactorily. It is also of special value in the case of late ripening varieties of tobacco such as Maryland, which, under some climatic conditions, barely succeed in reaching the stage of maturity necessary for commercial utilisation. There again, the plant must have arrived at a certain degree of development in order that the treatment may be effective.

It is also claimed that ethylene treatment, by maintaining the turgidity of the cells, decreases the rate of drying of the leaf and so reduces the risk of "green" drying when the weather is exceptionally dry or windy.

Finally, the stimulating effect of the gas on the enzyme actions continues for some time after its application has ceased, so that all those further changes that take place between the curing and the finished product are completed in a shorter time than would otherwise be the case.

The author makes the following recommendations for carrying out the process.

The chamber used should be of ample size to allow ready access to all the material to be treated. The temperature should be between 21°C. and 28°C., and should be kept as steady as possible. If the temperature is too low, the removal of the chlorophyll is inhibited, and at 15°C. the transformation of the green leaf is almost completely arrested. The precise optimum temperature is different for different varieties of tobacco, being in general that best adapted for the natural growth of the plant. The air in the chamber should be kept changed in order to remove carbon dioxide and any other objectionable products of decomposition. The atmospheric humidity should be maintained between 75 per cent. and 80 per cent. In order that the treatment may be effective, the leaves must have reached a stage of development at least nearly approaching physiological maturity. It is also desirable that they should not have been harvested following heavy rain.

REVIEWS.

MOTHER EARTH.

Letters on Soil, Addressed to Professor R. G. Stapledon, by G. W. Robinson. *Thomas Murby & Co.*, London, 1937. pp. 202, *Price* 5*s*. 6*d*.

MY DEAR ROBINSON,

You have addressed a series of seventeen open letters to your friend Professor Stapledon, whose vital interest in the proper utilisation of the ancient lands of Great Britain is so well known to many of us, and you have allowed other students free access to those letters in the book which I now wish to commend to a wider public.

Even in the tropics, much of what you have written is directly applicable to the problems that are the task, not only of the specialist soil investigator, but also of the tropical planter and the colonial administrator, to solve. Your method of appeal will doubtless attract the attention of the general reader and of all who have any interest whatever in the production of crops, for your book is most informal, quite untechnical, very interestingly written, and charmingly philosophical in its many whimsicalities. It is essentially a book for those who love the land for its own sake, and find in its cultivation the expression of their own genius, to coin one of your phrases.

I am particularly pleased to note that you stress the great importance of the ecological aspect of your subject, that is, the "contract" between soil and plant, as you so tersely put it. Thus, the problems of crop production must certainly lie as much in the province of the plant physiologist as in that of the pedologist. Further, soil chemistry is but a small subdivision of pedology, and a mistake is often made in the assumption that all the ills of the soil can be cured by a little artificial manure! One has but to read your letters on soil moisture, soil structure and soil fertility to disabuse one's mind of that fallacy. I agree with you too, in that, if I were asked what factor is most evident in controlling fertility, I should have no hesitation in voting for soil moisture, and its accompanying factor, soil aeration. Your dictum concerning water supply (p. 106) is one which I would quote for the benefit of tropical planters in particular, namely "In a settled country, a soil that by reason of its profile characters can so use the rainfall as to maintain an optimum supply of moisture for the use of crops will generally be found by experience to repay skilful cultivation and manuring." Would that this great truth were fully appreciated by those who are responsible for land settlement policies! There are many kinds of soil which, because of their inherent natural characters, can never be expected *economically* to produce high-yielding crops. Such soil should be put under the charge of foresters, who will at least see to it that they do not become a menace to their more favoured neighbours, by robbing them of their water supply, or subjecting them to devastating floods or burying them under wind-blown débris.

I have read your book with the greatest attention, and, as a teacher of pedology and crop ecology, I want to offer you my personal thanks for putting into my hands a much better means of conveying the fundamental truths of our subject than that offered by a disjointed series of lecture notes, for at least your method produces a readable story in which the main characters of the plot are conceived in their proper setting. Allow me to confess myself, in conclusion, one of your envious admirers.

Yours sincerely,

F. H.

* * *

INORGANIC CHEMISTRY.

A Survey of Modern Developments, by Sir G. T. Morgan and F. H. Burstall, *W. Heffer & Sons, Ltd.*, Cambridge, 1936. pp. 462, price 15*s*.

This book, as the title indicates, gives a review of the rapid and often startling developments that have occurred in the science of inorganic chemistry during the past few years. Thus, it was only in 1933 that the isotope of hydrogen was discovered, and the presence of "heavy" water as a normal component of ordinary water was recognised. In the last decade, remarkable progress has been made in the disintegration of the chemical elements, and in the production of induced radioactivity in non-active elements. Much further insight has been gained recently into the ultimate constitution of matter; the chemical structure of inorganic compounds, and the importance of the co-ordinate link, have been thoroughly investigated, in view of the fact that co-ordination compounds are finding increasing application in the arts, industry, and chemical analysis. These subjects are authoritatively discussed in several chapters, but the greater part of the book is given over to a systematic account of the chemistry of the metallic elements and their compounds, including the organo-metallic compounds. Although the book is somewhat "heavy going" for those whose training in chemistry has been elementary, yet it will prove a great asset to students who wish to bring their knowledge of the subject up to date.

F. H.

* * *

CHEMISTRY, MATTER AND LIFE.

By S. Miall and L. M. Miall, *Edward Arnold & Co.*, London, 1937. pp. 296, price 7*s*. 6*d*.

This book attemps to describe in simple language some of the main principles of chemistry, the nature of matter, and some of the chemical changes that take place in living plants and animals. The subjects include crystals; the rare gases of the atmosphere; X-rays; chemical attraction; catalysis; combustion and explosion; sugar, starch and cellulose; respiration and

digestion; the vitamins; fermentation; plant-growth; plant colouring matters, and inheritance, as well as several other topics. It will thus be seen that the ground covered is very broad indeed, so that the task would appear to be most formidable, except, perhaps, for writers having the wide experience that the senior author of this book at least has acquired, and such writers are rare.

The book can strongly be recommended as the best modern "popularisation" of chemical science that the reviewer can remember reading; it is readable and well illustrated by diagrams and photographic reproductions, and its subject matter is accurate and well documented.

F. H.

* * *

HERE'S HOW.

By G. St. J. Orde Browne, *East Africa, Ltd.*, London, 1937. pp. 186, price 5*s*.

This is a book which has been compiled for the dweller in the jungle, who will find it a mine of information of all kinds, and a ready help in many of the difficulties he is likely to experience. The author, Major Browne, who has just been appointed Labour Adviser to the Colonial Office, covers a very wide field, and, as a result of his long service in Africa, is in a position to give a most useful series of hints on existence in the house, the field or the office, at home or when travelling, in sickness or in health. Though it is easy to suggest that some of the information imparted, *e.g.* the number of gallons in a pipe of Madeira—or is it Marsala?—or the precise construction of a blackboard, is not likely to be wanted by the pioneer, there seems little of real importance that has been omitted, and the five shillings which is the price of the book should prove a good investment.

R. C. W.

* * *

THE ROTHAMSTED EXPERIMENTAL STATION REPORT 1936.

Price 2*s*. 6*d*., pp. 294. Obtainable from the Secretary.

The Annual Report of the Rothamsted Experimental Station fills a special place in the literature of science applied to agriculture. It reaches research workers in soil science and plant nutrition all over the world, and is of special interest to scientific workers, advisory officers and students in this country. It outlines the present position of the various investigations on soil and fertiliser problems conducted at the Station, and gives in full the yield figures for 1936 obtained from some 120 experiments carried out at Rothamsted, Woburn and numerous commercial farms in various parts of England.

An important section summarises the results obtained in experiments on soil cultivation during the last 11 years. Contrary to the widely accepted view the results obtained up to the present indicate that under the conditions prevailing at Rothamsted yields are not greatly dependent on the particular cultivation methods used, so long as the work is done at the right time. These trials must be continued but the figures already available are worth careful study. A preliminary discussion of the effects of fallowing on yields of wheat on Broadbalk Field brings out the striking difference of behaviour between the starved and the fully manured plots. When the yield is poor, fallowing produces a large increase in yield; in the presence of nitrogenous manures the effect is much less and may even be harmful in the first year following. The benefit due to fallow appears to be only of one year duration as measured in the wheat crop. Experiments on the incorporation of raw straw with an accompanying dose of artificials show that handled in this way straw has so far produced much the same effect as dung or Adco compost. Other sections of importance deal with experiments on dried poultry manure and the effect of fertilisers on sugar beet.

Long period surveys of the work of certain departments have been a feature of recent reports. This year the summaries deal with Field Experiments, Fermentation, Insecticides, and Entomology.

* * *

DIE ROHSTOFFGEBIETE DES TROPISCHEN AFRIKA.

By Dr. Leo Waibel, *Bibliographisches Institut Ag.* Leipzig, 1937, 424 pp.

This is a geographical, historical and economic survey of tropical Africa written essentially from a German view point. It contains particularly informative chapters on the development of African trade and communications, and on the economic resources of the principal raw material producing territories of the African continent and its island dependencies. The difficulties met with in establishing large estates on account of lack of labour and the changes brought about by the development of plantation and other industries, like mining, are discussed.

This book which is illustrated by some excellent maps should prove a useful work of reference.

* * *

CHRONICA BOTANICA.

From February of this year *Chronica Botanica* is being issued bi-monthly and no longer as a yearbook. The annual subscription will be reduced from 15 to 7 guilders. The new periodical will continue to give all the essential information which was given in the old yearbook and will include some important new sections. Results of research will be published only in the first two sections. The world list of plant science institutions and societies will appear as an annual supplement. The reorganized *Chronica* will contain short preliminary notes on the results of recent research or announcing new discoveries; discussions, announcements, letters to the Editor; detailed programmes, short reports, decisions, resolutions of international congresses; quotations from recent articles of general and timely interest; personal notes and queries; short review of new botany books, &c. The address is P.O. Box 8, Leyden.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Chlorinated Rubber.

The following abstracts from an article on this subject by Dr. J. P. Baxter and Mr. J. G. Moore are taken from *The Industrial Chemist* for December 1937, Vol. XIII, pp. 500-501.

The first important mention of chlorinated rubber is contained in a British patent taken out by Parks in 1846, which describes how the treatment of sheet rubber with gaseous chlorine improves the ageing resistance of the rubber. Later workers obtained patents for the chlorination of rubber in solution in carbon disulphide, benzene or chloroform. Gladstone and Hibbert, in 1888, passed chlorine into rubber dissolved in chloroform, and finally isolated a product of approximate formula $C_{10}H_{13}Cl_7$. In 1890, Edison patented the use of halogenated rubber for insulating electrical condensers.

Industrial development of the product dates from 1915, when Peachey took out a patent for a process of chlorinating rubber dissolved in chloroform or carbon tetrachloride. In 1917, the then United Alkali Company began at their works at Widnes the manufacture of Duroprene, a chlorinated rubber marketed chiefly as a solution for direct application. Later patents specified the use of chlorinated rubber in moulded articles, and for varnishes, adhesives, and coatings for concrete.

In 1934, Imperial Chemical Industries placed Alloprene on the market, and by 1935, five principal brands of chlorinated rubber were available—Alloprene (British), Tornesit (German and American), Tegofan (German), Pergut (German) and Detel (British). Three Japanese, one Italian and one other German firm are at present manufacturing chlorinated rubber, and recent patents have been taken out in Russia, France, Austria and Jugoslavia. Commercial development of the product was retarded by the high price of rubber until 1930, since when technical difficulties of production have been largely overcome; chlorinated rubber of satisfactory stability, solubility, colour, viscosity and film-forming properties is now available.

The product comes to the consumer as a cream-coloured powder, or as a floc-like material, of approximate formula $C_{10}H_{13}Cl_7$. It is prepared by the controlled chlorination of a suitable rubber solution. It has certain properties of outstanding importance to the paint and lacquer industry, in which the important factors are viscosity, strength, transparency and dielectric properties of film, and chemical and physical stability.

Chlorinated rubber is notably flame resistant. At 230° to 300°C., in the absence of oxygen, it merely chars with copious evolution of hydrochloric acid, which immediately smothers, not only the chlorinated rubber, but also any surrounding conflagration. It is therefore of considerable value as a lacquer ingredient which at the same time is a fire extinguisher.

Chlorinated rubber in the unplasticised state can be moulded under a pressure of from three to six tons per sq. in., at 135° to 140°C. Rigid temperature control is necessary, and the products are usually dark-brown and semi-translucent. Moulding temperature can be reduced by 15°C., by addition of five to ten per cent. of plasticiser. Opaque mouldings have been obtained by the use of fillers and pigments.

Chlorinated rubber mouldings compare favourably with other moulded insulating materials in regard to dielectric properties. A range of interesting plastics is prepared from Alloprene containing amounts of "Cereclor" and "Seekay" wax. Suggested uses for these chlorinated rubber plastic masses include tank linings and pipe jointing compounds, rubber plastics, non-inflammable dielectrics, sealing media, and as substitutes for linseed oil base in linoleum manufacture to improve flame and chemical-resistance in theatres, hotels and ships.

* * *

A New Method for Determining Available Phosphate in Soil.

The new method, evolved by Whitney and Gardener (1936), is totally different in principle from the more favoured methods, as it uses a hot dilute alkaline solution (one per cent. potassium carbonate) for extraction, instead of the dilute acids of the citric or Truog methods. It has many affinities with the more elaborate method of determining available phosphorus in the "matière noire" of Grandeau.

These "homo-phosphates" had not previously been studied in Mauritius soils, and the results obtained may shed new light on the debated phosphate question: Can the potassium carbonate-soluble-phosphorus, for instance, be taken as "fixed" or "unavailable", or is it possible for it to become gradually available? It is probable that such homo-phosphates represent an important stage in the phosphorus cycle, and, under tropical conditions of rapid mineralisation (well aerated lateritic soils), it may constitute the dynamic store of phosphorus in the soil. This method gave the following results when applied to Mauritian soils:—

	Lateritic Alteration.		Clay Alteration.	
	Top-soils.	Sub-soils (up to 4 ft.).	Top-soils.	Sub-soils (up to 3 ft.).
Number of Samples examined	**47**	**30**	**7**	**3**
Mgrs. "*available*" P_2O_5 % gr. dry soil (range)	132 mgr. to 6 mgr.	40 mgr. to 1 mgr.	179 mgr. to 8 mgr.	26 mgr. to 6 mgr.

(*Imp. Bureau of Soil Sci.* Summary of Recent Reports, Nov. 1937.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Automatic Juice Scales at Olaa Sugar Co. (T.H.) —*By C. J. Fleener.*

Improved Richardson equipment consists of two scales of the beam-and-lever type with tanks for the reception of the juice mounted on the scales. The beams have 5-lb. graduations and are provided with sliding weights for checking the accuracy. The amount of juice per hour is 3,000 lb. When the pre-determined weight of juice has been reached, the position of the outlet and inlet valves is automatically reserved. A float-controlled switch operated by the juice in the feed tank causes the scale to pause when the juice has fallen below the pre-determined level. This arrangement maintains the static head of the juice at the inlet valves within close limits. The tank is also equipped with an overflow outlet, and with an automatic alarm that operates when the juice in the tank is at the overflow level. The presence of an attendant is not required.—(*Int. Sugar Jr.*, Vol. XL, No. 470, p. 78, 1938.)

* * *

A Conductivity Method for Determining Water in Bagasse.—*By G. G. Rao.*

Some particulars of this new method have already been given.* When a definite quantity of the bagasse is digested with a solution of common salt of known electrical conductivity, the salt solution will be diluted, and the depression in its conductivity will be a measure of the amount of water present in the bagasse.

It is now pointed out that the conductivity imparted to the salt solution by the electrolytes in the bagasse cannot be ignored, and that a correction must be applied to allow for the conductivity of the "residual juice" in the sample. This fact limits the method to final bagasse, seeing that the presence of larger quantities of residual juice than are present in that product would render the results inaccurate.

This residual juice correction can of course be determined by ascertaining the specific conductivity of an aqueous extract of the bagasse, but this would be a duplication of work, as it means two digestions. Where the operating conditions are not varied, it is generally found that the residual juice correction can once and for all be determined, and its value used subsequently without appreciable error.

The extraction is most conveniently done in the familiar Deerr digestor, using a normal solution of NaCl instead of water. After extracting for an hour, the liquid is cooled to room temperature and polarized for its sugar content. The electrical conductivity of the original salt solution and of the extract is determined, both readings being taken at the same temperature. This is done simply by immersing the conductivity cell in a bath of water at room temperature for about 10 minutes. Then the water content of the bagasse is calculated by means of the following formula :—

$$W \text{ per cent.} = \frac{100\, v_1}{m} \times \frac{(C_1 + C - C_2)}{C_2},$$

in which v_1 is the volume of the salt solution; m is the grms. of sample used; C is the specific conductivity of a plain water extract prepared under the same conditions as the salt solution digest, *i.e.*, the conductivity due to the residual juice; and $C_1 - C_2$ is the apparent conductivity depression. Here are some of the results obtained by working in this way :—

$C_1 \times 10^6$	$C_2 \times 10^6$	$C \times 10^6$	True depression. $\times 10^6$	Water per cent.	
				Conductivity.	Drying.
4312	4085	99	305	43.6	43.1
4501	4245	90	355	48.8	48.5
7860	7434	92	516	40.5	41.7
7986	7510	96	568	44.1	44.3
7947	7535	121	508	39.3	39.7
7686	7371	121	436	34.5	34.8

Stronger solutions than normal cannot be employed because of the effect of the NaCl on the polarization. —(*Int. Sugar Jr.*, Vol. XL, No. 470, pp. 68-69, 1938.)

* * *

Probable Cost of Manufacture of Acetic Acid from Cane Molasses for the Rayon Industry.—*By K. C. Mukerji.*

At the suggestion of the Director of the Industrial Research Bureau, Cawnpore, the author has attempted to calculate the probable cost of manufacture in India of the acetic acid for use in the production of acetate and viscose artificial silk. By fermentation from molasses (assuming a yield of 300 lb. of acetic acid per ton of molasses) the cost per lb. is calculated to be 3.38 annas; by wood distillation, 4.45 annas; the same but applying the Melle process of direct distillation from the pyroligneous acid, 1.90; by fermentation and recovering the acetic acid from the washes by the Melle process, 1.88. Some information is given on the relative advantages of the acetate and viscose processes. In the case of the former, all three chemicals used (acetic acid, acetic anhydride and acetone) could be obtained locally from molasses, whereas with the other, the raw materials, caustic soda, sulphuric acid and carbon bisulphide, would have to be imported.—(*Int. Sugar Jr.*, Vol. XL, No. 470, p. 70, 1938.)

* *I.S.J.*, 1935, p. 76.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR:—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.):—

	Foreign.		*Preferential*	
	s.	*d.*	*s.*	*d.*
27th January	5	9¾	9	7½
3rd February	5	5¼	9	2¼
10th February	5	2¼	8	10½
17th February	5	5¼	9	2¼
24th February	5	3¾	9	0¾
3rd March....	5	3	9	2¼
10th March....	5	3	8	11¼
(11th *March*, 1937)	6	9	10	6

The absence of any announcement for an early meeting of the International Sugar Council, combined with a poor offtake for near at hand raws had a depressing effect on market sentiment and brought about fairly heavy liquidations, particularly of the March position. Terminal prices fell sharply, the lowest level reached being 5*s*. At the time of writing, however, the market had effected some recovery and the tone, although still hesitant, is distinctly steadier.

* * *

RUBBER.—Quotations for plantation sheet have ranged as follows:—

	Pence per lb.
26th January	7 1-8
2nd February	7
9th February	6 15-16
16th February	7
23rd February	7 5-16
2nd March	7 1-8
9th March	6 15-16
(10*th March*, 1937.)	11 7-16

The announcement that the International Regulation Committee had fixed the percentage of the basic quotas for the April-June quarter at 60 per cent. as the permissible exportable amount, was well received by the market. The fact also that the International Rubber Regulation Committee has approved a plan for the renewal for a further period of five years of the present restriction scheme should have a reassuring effect. Although there have been minor fluctuations in prices due to pronounced weakness on Wall Street, the tone of the Market has generally been firm. The *Questionnaire* figures and American consumption for January at 29,429 tons were, however, rather disappointing.

* * *

BANANAS.—The prices are unchanged at £16 5*s*. per ton delivered London and £16 nearest Station Provinces. Brazilians are firm at £14 delivered London and £15 Provinces.

COCOA.—The hold-up on the Gold Coast continued during the past month and in Accra frequent discussions have taken place between the chiefs and natives, and cable information indicates that they still show a decided determination to hold. The holding movement has resulted in a boycott by the natives of all imported goods. This factor, together with native threats to burn their stocks has caused the British Government to send out a Commission to investigate the whole situation. The price of Accra is quoted at 30*s*. c.i.f. and locally $6.10 per fanega is paid.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian Giza 7*	*F.G.F. Sakel.*
28th January ...	4.82	7.42	8.25
4th February	4.93	7.49	8.32
11th February	5.02	7.47	8.27
18th February	5.16	7.73	8.53
25th February	5.21	—	—
4th March	5.13	—	—
11th March	5.06	—	—
(12*th March*, 1937.)	7.94	—	—

Prices for raw cotton have risen on bullish reports from the United States concerning the limitation of next season's crop by legislation. The Farm Bill has been passed and although there is some confusion concerning its terms, it establishes drastic control of production. According to present arrangements the new crop is to be limited to 11½-12 million bales as against 18¾ million bales harvested last year. West Indian Sea Island has generally been neglected and there has been no business.

* * *

LIME PRODUCTS.—*Lime Oil.*—There is no demand for Handpressed with sellers at 32*s*. 6*d*. per lb. The last quotation of 25*s*. for Distilled is maintained for retail lots, but larger quantities are only saleable by negotiation. *Lime Juice.*—There is no demand for Concentrated and Raw is slow of sale and unchanged at 1*s*. 9*d*. to 2*s*. 3*d*. per gallon according to quality. (*West India Committee Circular*, 10th February.)

* * *

COFFEE.—Latest quotations per cwt. include Santos, superior: 29*s*. 3*d*.; Rio No. 7: 20*s*. 3*d*.; Kenya, good to fine parcels up to 119*s*. 6*d*.; Bold size London cleaned Costa Rica: 84*s*. to 123*s*. 6*d*.; medium size: 60*s*. to 75*s*.; country cleaned: 55*s*. to 68*s*. 6*d*.

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Dominica	Curtis, Campbell & Co.
St. Lucia	Peter & Co.
Barbados	Gardiner Austin & Co., Ltd.
St. Vincent	Corea & Co.
Grenada	Geo. F. Huggins & Co., Ltd.
Trinidad	Geo. F. Huggins & Co., Ltd.
Georgetown, B.G.	Booker Bros., McConnell & Co., Ltd.

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